# Control valve and parts of a turbocharger and a turbocharger boosting system comprising the same

The present invention relates to a control valve. The invention further relates to different parts of a turbocharger and a turbocharger boosting system comprising such a control valve.

Control valves comprising movable flaps are known from documents US-B1-6,295,815 and US-B1-6,263,672. The construction of such conventional control valves comprises a movable flap being pivotally arranged in a passage for controlling a fluid flow passing through the passage. In its closed state, the valve flap extends substantially perpendicular to the axis of the fluid passage. There are also different possibilities for arranging the pivotal axis about which the flap is turned for achieving a desired flap control position in the passage.

It is an object of the invention to provide an improved control valve as well as particular technical applications of its technical principle.

The object of the invention is achieved by the technical teachings set forth in the claims.

According to the invention there is provided a control valve comprising a movable flap for a controlled closing or opening of a fluid passage, wherein in the closed state the upstream side of said flap extends in a plane being inclined to the extension direction of the passage.

The control valve preferably comprises a flap which is pivotally movable about an axis located near the upstream end of the flap. More preferably the flap extends substantially in a plane separating the fluid passage in an inlet part and an outlet part being coupled to each other.

According to a further preferred embodiment the valve flap is supported on the outlet part of the fluid passage to close an opening of the outlet part which faces the inlet part of the fluid passage. In an alternative embodiment the flap is vice versa supported on the inlet part of the fluid passage to close an opening of the inlet part which faces the outlet part of the fluid passage.

According to a further solution of the invention there is provided a turbine housing comprising a valve according to the above described embodiments and being formed as a volute having an opening closed by the movable valve flap, wherein the opening and the flap in its closed state extend substantially in one plane being inclined to the axis of the volute. Such a turbine is preferably incorporated in a turbocharger.

The valve according to the invention is also preferably used in at least one passage of a turbocharger boosting system for performing a desired gas flow control. More preferably, the valve is arranged in an air supplying passage which connects a compressor of said turbocharger to the internal combustion engine.

According to another aspect of the invention a control valve is provided with a flap being formed as a bending plate with the upstream end thereof being fixedly positioned for resiliently opening/closing a second fluid passage at its merging point into a first fluid passage.

In an embodiment of such a control valve the first fluid passage preferably comprises a variable cross section at the merging point of the two passages, wherein more preferably the variable section increases in downstream direction of the first fluid passage. For achieving a variable cross-section the first fluid passage can be preferably provided with a detachable wall portion facing the bending flap.

In a further modification of the control valve the passages are formed in one single block member, which preferably represents an integral part of one of the compressor housings of a turbocharger boosting system.

According to another aspect of the present invention there is provided a compressor housing of a turbocharger comprising a control valve according to one of the above described embodiments. According to still another aspect of the present invention there is provided a turbocharger comprising such a compressor housing.

Particular embodiments of the invention as well as alternative solutions thereof will be described in the following with reference to the enclosed drawings.

In the drawings:

Fig. 1 shows a cross-sectional side view of a turbine housing system comprising a control valve according to a first embodiment of the present invention, said valve serving as a flow restricting valve positioned in a passage connecting the exhaust of an internal combustion engine with a turbine housing of a turbocharger;

Fig. 2 shows a front view of the control valve of Fig. 1;

Fig. 3 shows a back side view of the turbine housing system shown in Fig. 1;

Fig. 4 shows a cross-sectional side view of the turbine housing system of Fig. 1 for illustrating the exhaust gas flows and the opening of the control valve according to the first embodiment of the present invention;

Fig. 5 shows a front view of a turbine housing system comprising a control valve according to a second embodiment of

the present invention, said valve serving as a flow restricting valve positioned in a passage connecting the exhaust of an internal combustion engine with a turbine housing of a turbocharger; and

Figs. 6a, 6b show a cross-sectional view of a control valve according to a third embodiment of the present invention.

In the embodiment shown in Figs. 1 to 4 a first turbine housing 1 of a first turbocharger and a second turbine housing 2 of a second turbocharger are provided one above the other and coupled in an appropriate space-saving manner. Both turbine housings 1 and 2 comprise volutes for delivering exhaust gas to the respective turbines not particularly shown in the drawings.

The volute of the turbine housing 2 has an inlet part or intake passage 3 provided with a first flange portion 5 which is fixedly coupled to a second flange portion 7 of a main exhaust pipe or passage 9 by means of which exhaust gas G is delivered through a control valve 11 to the turbine of the second turbocharger. Upstream of the valve 11 there is provided a further passage 13 branched-off from the passage 9. The branch-off passage 13 serves for delivering exhaust gas to the first turbine housing 1 of the first turbocharger which is not completely shown in the drawings.

As can be understood from the illustration of Fig. 1, the turbine housing 2 is formed as a separate element with the control valve 11 being arranged such as to close or open the opening of the inlet part 3 of the volute. The control valve 11 comprises a movable flap 15 which by means of an arm element 17 is pivotally supported on an axis 19. Thus, a rotation of the axis 19 causes a turning movement of the flap 15 for closing or opening the inlet part 3 of the turbine housing 2. Of particular advantage is the fact that the inlet part 2 extends substantially coaxial with the main passage 9 of the manifold,

thus enabling the exhaust gas to go straight to the volute of the second turbine housing without substantial lost of energy.

In the embodiment shown in Figures 1 to 4 the main exhaust pipe 9 is formed as manifold comprising also the first turbine housing 1 of the first turbocharger. For this purpose the main exhaust pipe 9 is provided with a flange 8 to be fixedly connected to exhaust manifold of an internal combustion engine which is not particularly shown in the drawings. Alternatively, the main exhaust pipe 9 can be incorporated in the exhaust manifold to form an integral construction unit.

On the flange 8 there is fixedly supported a plate member 10 by means of bolts 12 for carrying an actuating device 14. The actuating device 14 is provided with a rod 16 hinged by means of an adjusting device 21 to an actuating lever 23 fixedly connected to the axis 19.

In its closed position the flap 15 extends substantially in the plane of the opening defined by the flange member 5 as particularly shown by the illustration of Fig. 2. Furthermore, the upstream surface or plane of the flap 15 extends in a plane being inclined to the extension direction of the inlet passage 3 of the turbine housing 2 such that the axis 19 is attached near the upstream end of the flap 15. In the present embodiment, the valve flap 15 is positioned at an angle $\alpha$ of about 45°. Due to its inclined arrangement of its upstream side, the flap needs to be turned at a relatively small angle, in order to open the intake passage 3. Because of this arrangement of the valve flap 15, also the machining and assembling of the valve parts become easier and the function of the valve becomes more reliable. In the present particular embodiment the volute including the valve 11 can easily be dismounted from the manifold including the main exhaust passage 9 and maintained if necessary.

A further advantage of the inclined arrangement of the valve flap 15 is that the flap can be simply biased by a spring in its closed position shown in Fig. 1, so that the valve can easily serve as a check valve the opening state of which can be adjusted by adjusting the spring force.

The valve construction according to the invention considerably improves the control of the air flow and decreases the energy lost by air friction. As particularly shown in Figure 4, the valve flap 15 arranged in the above-described manner prevents to a large extent perturbations of the exhaust gas flow S2 entering the volute of the second turbine housing 2 and thus ensures a steady function of the turbine in the second turbocharger without significant vibrations.

Furthermore, the opening of the first flange member 5 which - because of its inclination - is relatively large, makes it possible to achieve a very stable attachment of the turbine to the main exhaust passage 9. At the same time the inclination is such that it helps position the turbocharger body with respect to the unit including the main exhaust passage 9 such that space for the installation of the turbocharger and the complete turbocharger boosting system can be saved.

The invention is not limited to the embodiment shown in Figs. 1 to 4.

For example, according to a further embodiment of the control valve, the flap 15 can be inclined at any other appropriate angle in respect to the axis of the exhaust passage 9 and it can be also supported directly on the passage 9. The second branched-off passage 13 for the turbine of the second turbocharger can optionally also be provided with a control valve according to the invention.

Still according to a further preferred embodiment according to the invention the valve flap is made of sheet metal.

According to a second embodiment shown in Figure 5, the flap 115 of the valve 111 has a semi-elliptical shape which provides a flow control with improved precision. In this embodiment the turbine housing case can be fully machined. Further advantages are that there is a low air swill, the opening of the valve has a progressive characteristic and provides a good exhaust gas flow control.

In Figures 6a and 6b there is shown a third embodiment of a control valve 211 according to the invention as applied on the compressor side of a turbocharger boosting system. Such a valve comprises a movable flap formed preferably as a thin bending plate 215 the upstream portion or end 215a of which is bolted by a screw 215b to the wall of a first passage 203. In this embodiment the first passage is the air discharge passage of a first compressor of a turbocharger boosting system, which however is not particularly shown in the figures. The first passage 203 as well as a second passage 209 for discharging air from a second compressor are machined in a single block member or body 227 constituting the compressor housings of the turbocharger boosting system.

In the present third embodiment of the control valve according to the invention the second passage 209 extends in a direction inclined to the axis of the first passage 203, wherein the bending plate 215 covers an opening of the first passage where the second passage merges into the first passage. The bending plate is bolted by the screw 215b to a portion of the block member 227 upstream of the merging opening of the second air passage 209 so that under operating conditions of the turbocharger boosting system where the pressure in the second air passage is higher than the pressure in the first air passage, the flap member 215 bends away from the opening as shown in Fig. 6b, so that the air discharged from the second passage 209 can smoothly enter the first air passage without causing any significant perturbations by mixing with the air

discharged from the first air passage. For this purpose the angle between the axis of the merging second air passage 209 and the axis of the portion of the first air passage extending downstream of the merging point is preferably more than 90°.

Furthermore, in order to achieve a perturbation-free merger of the first and second air stream, the wall portion 231 of the first passage 203 facing the bending plate 215 is formed such as to provide a widening of the cross-section of the first passage in downstream direction. As shown in the Figures 6a and 6b this wall portion is formed by a separate calibration element 225 detachably mounted on the block member 227 by means of a fixation screw 229. Thus, the cross-section of the first passage can be calibrated by replacing the calibration element 225 by another one having a differently formed inner wall portion 231. Alternatively, a single calibration element can itself be adjusted to provide an inner wall portion 231 of varying cross-section. For example, such an element could be adjustable using set screws.

Due to its construction the control valve 211 can serve as an automatic mixing valve without an external control, providing low energy lost because of diminished air friction. It is a kind of a diaphragm valve, preferably made of sheet metal which works like window similar to a retention valve. In the closed state of the valve 211 the bending plate 215 serving as a diaphragm, which can be preferably formed also as a plate spring, remains slightly biased against the merging opening of the second air passage. Thus, diaphragm vibrations caused by engine vibrations can be efficiently suppressed. The diaphragm valve 211 will however reliably open when the dynamic pressure created in the second passage 209 by the second compressor becomes higher than the force provided by the combination of the bias force of the bending plate 215 and the static pressure on the first compressor and in the first air passage 203.

The invention is not confined to the embodiments described above.

For example the control valve comprising the bending plate or diaphragm can be preferably incorporated in the compressor housing of the second compressor of a turbocharger boosting system. Furthermore, instead of the bending plate the valve can be made with a rigid design and pivotally supported for opening/closing the respective passage.

A control valve comprising the bending plate or diaphragm can be used also in a bypass passage on the turbine side of a turbocharger boosting system as explained above.